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Review of Taiwan's climate policy after Copenhagen☆

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ABSTRACT

The Copenhagen Accord in 2009 initiated new opportunities for international cooperation in reducing greenhouse gas (GHG) emissions. The purpose of this study was to review Taiwan's current climate policy and, in response to the Copenhagen Accord, to deliberate this policy in the light of new strategic thinking. The study proposes a two-stage approach with a dividing line in 2020. In the first stage, from now until 2020, strategy should be based on cost constraints, with a suggested reduction cost below \$60/t-CO_2, and implementation of domestic GHG emissions trading scheme and reduction strategies. In the second stage, from 2020 and beyond, action by Taiwan should, accord with international cooperative actions to link its domestic emissions trading scheme with the international carbon market.

Contents

1. Introduction

Since the 1980s, climate change issues have become important concerns to the world. Increasing evidences lead to the belief that climate change is caused by human activities, and humans are facing the great challenge from climate change [1].

In the early 1990s, the United Nations created a new climate regime and sought to resolve this challenging issue. The United Nations Framework Convention on Climate Change (UNFCCC) adopted in 1992 was the beginning of the international climate regime [2]. Afterwards, the Kyoto Protocol was passed in 1997 and aimed at developed countries (Annex I parties) by setting mandatory GHG emissions reduction targets for the period from 2008 to 2012 [3]. Presently, the two most important regimes in response to climate change are the UNFCCC and the Kyoto Protocol. After the Kyoto Protocol came into effect in 2005, parties began to discuss the post-Kyoto period, and the issue of post-2012 regulation remained open. Currently, the goal that the world is trying to set is to stabilize GHG concentration in the atmosphere at 450 ppm by 2100 to

☆ The views expressed in this paper are those of the authors and should not be attributed to Chinese Culture University and National Taiwan University.

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prevent the temperature increase over two degrees Celsius [1,4,5]. To achieve this goal means that global GHG emissions must peak before 2020 and be half of 1990 emission levels in 2050 [5]. By the end of 2009, the 15th Conferenece of Parties (COP15) of the UNFCCC formally put forward the Copenhagen Accord, bringing the international climate change political negotiation a step forward [6].

Although developing countries do not have the responsibility to reduce GHG emissions, international pressure for their GHG emissions reduction is increasing everyday. China, as an example, has become the largest GHG emissions country and is facing a voluntary reduction commitment in response to the pressure [7]. On the other hand, GHG reduction is not just an international negotiation issue. It means that every country has to pursue the maximum economic well-being under such reduction regulation [8].

Taiwan, with its complex international political status, must over the years face the views of other members of the global village in order to fulfill its obligations vis-à-vis international environmental conventions [9]. Taiwan's government and academia have not waived the obligation to comply with international conventions to which Taiwan is not a party if those conventions affect areas bordering Taiwan.

Taiwan has not been able to join the existing international climate regime because of its ambiguous political status [9]. However, in the face of possible formation of new international agreements in the future post-Kyoto period regarding all countries with a high degree of impact, it should be assessed whether or not Taiwan should negotiate or continue to endure in silence as has been the case in the past. Taiwan faces both internal and external difficulties in the evolution of the international climate framework. Reduction is difficult to clarify in its own internal space and, externally, very difficult in international practice. This dilemma will indeed be a special case on the edges of a common response to global climate change.

This study analyzes the current progress of the international climate regime and an overview of the current climate policy in Taiwan. It proposes strategic deliberations for a response scheme. This paper is organized as follows: Section 2 describes the progress of the international climate change regime with analysis on a multi-track performance system and the importance of market mechanisms; Section 3 addresses Taiwan's GHG emissions and its dilemma of climate policy development; Section 4 analyze difficulties encountered in Taiwan's climate policy; Section 5 conducts a strategic analysis of the proposed two-phase response Taiwan faces in the post-Kyoto period; and Section 6 draws several discussions and conclusions. As Taiwan's economic development status lies between Annex I parties and non-Annex I parties, understanding the situation in Taiwan can serve as a bridge between those two different positions.

2. Post-Copenhagen negotiations

Pursuant to the Kyoto Protocol, adopted in 1997, most important to establish was that countries have "common but differentiated responsibility" and for Annex I parties to set "quantified emission limitation and reduction objectives" (QELROs).

In addition, the Kyoto Protocol set up three international cooperation mechanisms for reduction, namely, Joint Implementation (JI), Emissions Trading (ET), and a Clean Development Mechanism (CDM), the operation of which mechanisms is mainly to assist Annex I countries to achieve a more flexible approach as specified in the Kyoto Protocol targets [3]. Because of these mechanisms, a new global carbon market can be created.

In fact, the Kyoto Protocol established a simple type of reduction mechanism, that is, constraints, both absolute and for GHG emissions to reach a macroeconomic limit. Although from the points of view of environmental effectiveness and economic efficiency the Kyoto Protocol is a useful specification, from the political and practical points of view it is detrimental to developing countries to participate [10]. Since the 1997 Kyoto Conference, global GHG emissions have increased by 25%, indicating that the current climate framework does not generate immediate effects. Furthermore, in the past, international financial and technical support for developing countries has been insufficient to the development of low-carbon societies due to a lack of adequate funds for technology transfer [10].

Since the Kyoto Protocol came into force in 2005, the individual national focus of negotiations has shifted to how to maintain the first commitment period (2008–2012) of the international climate framework. In 2007 in Bali, Indonesia, the 13th Conference of the Parties adopted the Bali Action Plan, requiring member countries to reach the end of 2009 pursuant to Kyoto Protocol negotiations, with agreement in January 2013 prior to implementation. It also required all industrialized countries to fulfill measurable, reportable, and verifiable (so-called MRV) GHG reduction responsibilities and required developing countries to adopt national appropriate mitigation actions (NAMAs) [11].

The 15th Conference of the Parties (COP15) held in Copenhagen, Denmark, in December 2009 did not pass the legally binding agreement anticipated worldwide but instead concluded the Copenhagen Accord [6]. The first page of the Convention agreement adopted a "cognitive" rather than the "resolution" approach commonly used in the past to signify all states party to the agreement and has not been recognized. The agreement contained 12 articles and two schedules. The first schedule required Annex I countries to fulfill their quantified economy-wide reduction targets by 2020, while the second schedule required non-Annex I countries to submit NAMAs.

Despite differing textual evaluations and degrees of resistance to the Copenhagen Accord by various sectors, the major countries involved in the negotiations, such as the United States and China (in contrast to the previous position of the U.S. rejection of the Kyoto Protocol) and other countries at the meeting were willing to slow down to discuss climate change at the negotiating table, probably the most important step forward since the Kyoto Conference in 1997.

2.1. *Multi-track forms of compliance*

To encourage countries to propose post-2012 GHG reduction targets, the Europen Union (EU) pledged to reduce GHG emissions by 20% by 2020 based on 1990 levels or 30% if there was a global agreement [11–13]. President Barack Obama set a target of reducing U.S. GHG emissions in the range of 17% below 2005 levels by 2020 and by 83% by 2050 in line with final legislation [14]. Other major developed countries, such as Japan, also started to draft new specifications to replace the Kyoto Protocol GHG reduction targets.

Developing countries are persistently unwilling to commit to reduction responsibilities. To enable developing countries to join the ranks of the global fight against climate change on a fairer, more reasonable basis, a number of proposals are currently being discussed, the basis of argument being the shared obligation for GHG reduction (burden sharing). The equity foundation is very important in addressing climate regime [15]. In discussing reduction obligation in developing countries, equity and environmental objectives should be ranked as the first core element, followed by discussion of burden sharing, which is considered a national responsibility and capacity [10,15,16].

In order to integrate economic development and climate change efforts, research shows that the in the post-Kyoto climate framework most countries must become more flexible, taking into account the characteristics and strategies of various countries; in

Table 1
Quantified economy-wide emissions targets submitted by selected Annex I parties for the Copenhagen Accord.

Annex I parties	Emissions reduction in 2020	Base year
Canada	17%	2005
EU	20–30%	1990
Japan	25%	1990
Russian Federation	15–25%	1990
Switzerland	20–30%	1990
United States of America	17%	2005

particular, the reduction efforts of countries should be considered individually. Moreover, the climate framework should apply a more flexible "integrated multi-track" mechanism. The multilateral trade regime includes agreements accepted by all World Trade Organization (WTO) members and multilateral agreements among smaller groupings of members. The Convention on Long-Range Transboundary Air Pollution, the International Convention for the Prevention of Pollution from Ships, and other international agreements adopted core protocol agreements with different obligations listed in their annexes [10].

The voluntary GHG reduction actions in developing countries are of high concern. The IPCC Fourth Assessment report indicated that, to stabilize GHG concentrations in the atmosphere at 450 ppmv, non-Annex I countries need to substantially reduce 2020 emissions relative to the baseline scenario, especially in Latin America, the Middle East, East Asia, and Central Asia [1].

Before the Copenhagen meeting, South Korea officials said the country's first GHG reduction targets for 2020 would reduce its CO_2 emissions by 30% compared with the baseline scenario, approximately equal to emissions in 2005 minus 4% [17]. Singapore's government announced that the city–state would undertake voluntary and domestically funded action to reduce emissions growth to 16% below business as usual (BAU) levels by 2020 [18].

Tables 1 and 2 are compilations based on proposed reduction commitments of Copenhagen Accord countries [19,20]. The contents of the Accord shows that Annex I parties are required to conduct absolute reduction, while non-Annex I parties shall adopt mitigation compared to the baseline. It is believed that this clear principle to distinguish the responsibilities between Annex I parties and non-Annex I parties will continue to hold up for the negotiation in the post-2012 era. These two distinct reduction modes are believed to be the direction of post-Copenhagen negotiations as well as the starting point the world must face in mitigating climate change via a multi-track form of compliance.

2.2. Development of market-based mechanism

The Copenhagen Accord especially mentioned: "We decide to pursue various approaches, including opportunities to use markets, to enhance the cost-effectiveness of, and to promote mitigation actions." On the positive side, the Accord states that the Parties should pursue opportunities to use markets to achieve cost-effective abatement. This language could be interpreted as being as close as one can get to an agreement on linking of markets [21].

Table 2
Voluntary GHG reduction pledges submitted by selected non-Annex I parties.

Non-Annex I parties	GHG reduction pledges
Brazil	36.1–38.9% below BAU by 2020
China	40–45% emission intensity reduction below 2005 levels by 2020
India	20–25% emission intensity reduction below 2005 levels by 2020
Indonesia	26% below reference levels by 2020
Mexico	Up to 30% reduction below BAU by 2020
South Korea	30% below BAU by 2020
Singapore	16% below BAU by 2020

The key to solve climate change issues is putting a price on carbon [5,16], and Stern also believes carbon pricing is the core of climate policy. Accurate prices can be described as a kind of incentive for consumers and producers to take action, that is, to internalize externalities. In addition, accurate price is conducive to efficiency in GHG reduction in that it keeps the costs of reduction below this price [16].

The Kyoto Protocol established a period of five years from 2008 to 2012 to set up an inter-governmental trading scheme covering 37 member countries and accounting for about 29% of 2004 emissions of CO_2 [22]. At present, many countries or regions are implementing emissions trading schemes for GHG emissions. The EU was the first region to promote a large-scale carbon trading scheme, and other countries are likely to follow the EU practice in the design of carbon trading schemes. The EU in January 2005 launched an emissions trading scheme (EU Emissions Trading Scheme, EUETS), with annual trading volume of about 2 Gt carbon and total value of transactions of approximately \$50 billion [23]. On January 1, 2008, EUETS entered its second stage. Although the United States did not ratify the Kyoto Protocol, some areas within the country have promoted the trading scheme. The U.S. Regional Greenhouse Gas Initiative (RGGI) comprised the electric power industry in ten states in the northeast promoting a GHG reduction plan, with a goal of 10% reduction in GHG emissions between 2009 and 2018 [24].

It can be expected that emissions trading will play an important role in the post-Kyoto process, which aims for further reductions of GHG emissions [25]. International emissions trading is widely seen as an indispensable policy pillar of climate change mitigation [26]. However, this system requires careful design; otherwise it will not promote the task of carbon reduction or even be counterproductive [27].

3. A review of Taiwan's climate policy

Establishing climate policy should include policy formation, implementation, and review, while simultaneously establishing a revolving review mechanism [28]. Climate policy should be melded with the UNFCCC and the spirit of the Kyoto Protocol, with full attention to domestic and foreign consultative communication, efficiency, results, and regular policy review.

3.1. The status of GHG emissions

Taiwan Environmental Protection Administration's (EPA) statistics showed that GHG emissions from 1990 to 2008 in Table 3 [29]. Taiwan's total GHG emissions, from 145.20 million metric tons CO_2 equivalent in 1990 (Land Use, Land-Use Change and Forestry, LULUCF, excluded), had already reached 289.79 million metric tons CO_2 equivalent in 2008, a 99.58% increase in emissions and an average annual emissions growth rate of 3.91% in 2008, compared to 4.08% in 2007.

Based on types of greenhouse gases, CO_2 emissions in Taiwan were highest, followed by N_2O and the F-gases. Between 1990 and 2008, CO_2 emissions increased 121.96% with a 4.53% average annual rate of increase, CH_4 emissions 58.87% with a −4.82% average annual rate of increase, and N_2O emissions 10.02% with a −0.59% average annual rate of increase.

By sector, the energy sector in 1990 accounted for 75.07% of Taiwan's total GHG emissions (excluding LULUCF sinks), the industrial processes sector 8.08%, the agricultural sector 9.80%, and the waste sector 7.05%. In 2008, the energy sector accounted for 88.39% of Taiwan's total GHG emissions (LULUCF excluded), the industrial

Table 3
Trends of GHG emissions in Taiwan, 1990–2008 Unit: Million metric tons carbon dioxide equivalent.

Year	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	CO_2 Absorbtion	Total GHG emissions	Net GHG emissions
1990	120.17	12.45	12.58	N.A.	N.A.	N.A.	−18.70	145.20	126.49
1991	130.12	11.69	13.36	N.A.	N.A.	N.A.	−16.95	155.17	138.22
1992	139.80	12.58	13.26	N.A.	N.A.	N.A.	−18.98	165.64	146.66
1993	151.37	13.89	13.57	N.A.	N.A.	N.A.	−19.11	178.83	159.73
1994	159.44	14.47	13.84	N.A.	N.A.	N.A.	−19.17	187.75	168.58
1995	166.87	16.01	13.83	N.A.	0.62	0.30	−19.21	197.62	178.41
1996	175.90	15.96	14.17	N.A.	0.96	0.52	−19.13	207.51	188.38
1997	187.67	15.89	12.43	N.A.	1.62	0.66	−19.28	218.27	198.99
1998	198.01	15.58	12.03	N.A.	1.62	0.85	−19.30	228.09	208.80
1999	207.54	15.10	12.41	N.A.	2.42	1.15	−19.30	238.62	219.32
2000	224.75	11.46	12.67	0.47	3.56	0.70	−19.36	253.61	234.25
2001	232.45	9.63	12.69	N.A.	4.22	N.A.	−18.60	258.99	240.38
2002	241.57	7.66	12.50	1.90	4.51	4.47	−19.55	272.62	253.06
2003	250.60	6.59	11.58	1.82	4.77	4.36	−19.62	279.72	260.09
2004	259.42	6.30	12.12	1.91	5.13	5.17	−19.67	290.04	270.37
2005	266.02	5.39	11.88	0.62	3.81	5.21	−19.63	292.93	273.30
2006	274.60	4.90	12.12	1.21	4.03	4.69	−19.74	301.55	281.82
2007	278.01	4.53	11.91	0.18	3.82	3.63	−19.73	302.08	282.35
2008	266.73	5.12	11.30	0.16	2.10	4.36	−19.81	289.77	269.96

Notes: N.A. on the table indicates "Not Applicable", no emission in this section.

processes sector for 6.42%, the agricultural sector for 3.93%, and the waste sector for 1.26%.

According to the above analysis, CO_2 emissions from energy related combustion have historically been Taiwan's largest source of GHG emissions [30]. Taiwan's CO_2 emissions from energy related combustion in 2008 were about 1% of global emissions, 22nd highest ranked worldwide, as shown in Table 4 [31]. CO_2 emissions in Taiwan exhibited negative growth for the first time in 2008, the largest drop being energy sector CO_2 emissions from combustion. Therefore, aside from Taiwan's government promoting energy conservation, the global financial crisis should also be counted as a factor in reducing GHG emissions. The growth of Taiwan's GDP and energy consumption are strongly related and exhibit bi-directional causality; GDP affects energy consumption, while energy consumption also affects growth of GDP [32,33], so a decline in GDP also results in reduction of CO_2 emissions.

In addition, using Long-rang energy alternative programme (LEAP) model evaluation, with no new control strategies in the BAU scenario, Taiwan's energy sector CO_2 emissions will reach 442 million metric tons by 2020 and 531 million metric tons by 2030, the main future source being coal-fired power plant emissions [34].

3.2. Climate policy content

Good energy policy is usually good climate policy [35]. As can be seen from the structure of Taiwan's GHG emissions, CO_2 emissions from energy combustion form the main axis for GHG reduction, so Taiwan's climate policy is actually its energy policy. In 2008 Taiwan's Executive Yuan (Cabient) proposed a new energy policy, the Framework of Taiwan's Sustainable Energy Policy (FTSER), which is mainly divided into two energy supply and demand management axes, to promote GHG reduction. The Executive Yuan also declared 2010 as "energy saving and carbon reduction year," hoping that CO_2 emissions in 2020 could return to 2005 levels and 2025 emissions to 2000 levels. Major policy items are as follows [36]:

- *Cleaner energy supply*: Restructure energy mix and improve energy efficiency.
  - (1) Increase energy supply diversity. Reconsider the nuclear power as a no-carbon energy option.
  - (2) Increase the utilization of low carbon natural gas, to account for more than 25% of power generated in 2025.
  - (3) Develop carbon-free renewable energy. Effectively explore its power generating potential, so that the share of renewable energy in the electricity system could reach 8% by 2025. Increase the share of low carbon energy in electricity generation systems from the current 40–55% in 2025.
  - (4) Accelerate the replacement of older power generating units. Formulate a power plant efficiency improvement program to require new built units to apply the best available technology.
- *Rationalized energy demand*: Promote energy conservation schemes in various sectors
  - (1) *Industrial sector*: Reform the industrial sector towards a high value-added and low energy intensive structure, so that its carbon intensity could be reduced by more than 30% by 2025.
  - (2) *Transportation sector*: Provide a convenient mass transportation system to reduce the usage of private vehicles. Construct an intelligent transportation system to provide instant traffic information and enhance traffic management capacity. Raise the fuel efficiency standard for private vehicles by 25% in 2015.
  - (3) *Residential and commercial sector*: Improve urban planning, as well as promote forestation in urban areas to create a low carbon city. Raise appliance efficiency standards by 10–70% in 2011. Further raise the efficiency standards in 2015 to promote high efficiency products.
  - (4) *Public sector*: Reduce the energy use of governmental agencies and schools by 7% in 2015. Integrate carbon neutral concept into policy planning.

Drawing the most outside attention to the proposed new energy policy framework is the promotion of nuclear power as a low-carbon energy option. In 2001 Taiwan proposed a Non-Nuclear Homeland policy, thereby excluding nuclear energy as a greenhouse gas reduction option. The construction of nuclear power plants in Taiwan is not only an energy issue but a highly sensitive political issue. Taiwan's fourth nuclear power plant, under construction since March 1999 and with a history of construction halts and restarts, has yet to be commercially viable operation. Now, whether or not reiteration of nuclear energy as a low-carbon energy option receives public support may be subject to follow-up observation.

In addition, the FTSER has also referred four bills, including the Renewable Energy Act, the Energy Management Act, the draft Energy Tax Bill, and the draft Greenhouse Gas Reduction Bill. The Greenhouse Gas Bill would authorize the EPA to set a domestic GHG reduction target (a cap) and introduce an emissions trading scheme in the future.

Table 4
Comparison of CO_2-related indicators.

	Taiwan (Rank)[a]	Global	OECD	Japan	Korea	U.S.	China
CO_2 emissions (million tons)	264.29 (22)	29,318	12,630	1151.14	501.27	5595.92	6508.24
Population (million)	22.92 (48)	6688	1190	127.69	48.61	304.53	1325.54
CO_2/population (tons/capita)	11.53 (17)	4.39	10.61	9.02	10.31	18.38	4.91
CO_2/GDP(PPP) (kg/2000 US$)	0.41 (52)	0.46	0.38	0.32	0.44	0.48	0.60

[a] The number in parentheses is Taiwan's rank order out of the world.

However, most attention is directed on the energy tax legislation. Although energy tax regulations are considered to be one of the most effective GHG reduction strategies, voters do not like to hear the word "tax" unless it is followed by the word "cut" [37]. Therefore, although the energy tax or carbon tax has been continually proposed over the years, only limited discussion has occurred, with legislation still a long way off. To achieve this new set of energy policy goals, Taiwan's government has developed over two hundred plans to promote implementation.

4. Difficulties encountered in Taiwan's climate policy

Since 1992, Taiwan's government began plans to set up an interministerial policy steering group, then held three National Energy Conferences in 1998, 2005 and 2009 [9,30]. These frequent national meetings, besides highlighting the concerns of Taiwan on these issues, further demonstrate the difficulties involved in reducing greenhouse gas emissions and the need to hold multiple meetings to achieve consensus.

Taiwan relies 99% on imports for its main energy source of fossil fuels. Adjustability of energy supply structure in space is very limited, so strengthening energy technology development becomes relatively more important. However, over the past three meetings, close to two hundred action plans have been proposed with no concrete results. In fact, Taiwan's climate policy is affected by three main domestic and foreign factors:

4.1. Lack of clear GHG reduction cost

Ideally, politicians who want to save the planet would be honest with voters about how much this will cost [37]. The UNFCCC GHG reduction strategy also emphasizes the importance of cost effectiveness [38,39]; moreover, having a clear strategy means to input "cost" and "GHG reduction effects" according to each country's national capacity in a incremental manner, with lowering the cost of implementation given priority.

Over the past decade, Taiwan has proposed numerous GHG reduction strategies, yet lack of a clear cost reduction concept, a clear carbon price signal, and clear cost or pricing information has caused a blind spot in the task of promoting carbon reduction. Without knowing the status of the assessment, the cost of the proposed reduction strategy is already higher than the cost to Annex I countries. The private sector is unable to understand government commitment to reduction and is concerned about and resistant to taking over responsibility for reduction [34]. Careful analysis of recent GHG programs, in fact, shows they are mostly textual descriptions of visions and goals or revised using indirect indicators of estimated results. For example, energy intensity and energy productivity are included to expand adjustment space of GDP factors. In the absence of clear reduction of costs, effort to promote reduction is very limited.

4.2. Status under the UNFCCC not clear

Fear of trade sanctions is thought to be a primary consideration as Taiwan addresses its response to to international environmental treaties. For example, when the Montreal Protocol which controlling ozone-depleting chemicals took effect in 1989, Taiwan was apprehensive that the fledgling electronic industry would meet severely impacts by the protocol and immediately referred to the control of ozone-depleting chemicals in non-Article 5 Parties (developed countries) for action. Since 1996, there has been a total ban on production and imports of chlorofluorocarbons (CFCs), halons, and carbon tetrachloride (CCl_4). In addition, production and consumption of methyl bromide and hydro-chlorofluorocarbons (HCFCs) have also been gradually restricted [40]. However, China, India and South Korea are still considered developing countries (Article 5 Parties) under the Montreal Protocol; the schedule for control of the relevant chemicals is delayed for at least 10 years, and the baseline for reduction is also more relaxed [41]. With the passage of the 1997 Kyoto Protocol, the focus of thinking in Taiwan was, first of all, its own status under the convention (Annex I or non-Annex I party) and, secondly, how to determine its own reduction targets despite the Protocol not requiring non-Annex I parties to meet reduction obligations. To prevent trade sanctions and in consideration of its past response to other conventions, Taiwan will give top priority to set GHG reduction target.

Now facing the post-Kyoto era, clear understanding is needed first. In legal aspect, when the Kyoto Protocol was passed in 1997, Taiwan was not listed as Annex B party. If a country is not Annex B party, it has no immediate reduction responsibility for 2012 and should not plan on reduction as an Annex B party. Turkey has been actively involved in negotiations for an exemption from listing as an Annex II party under the UNFCCC and an Annex B party under the Kyoto Protocol [42]. This example demonstrates that there is no need for Taiwan to identity itself as an Annex B party. Further, the Copenhagen Accord passed in COP15 in 2009 clearly distinguishes Annex I parties reduction and non-Annex I parties mitigation. Taiwan's government should have a clear understanding of such issues.

4.3. Unable to participate in international cooperation

Taiwan's past participation in UNFCCC conferences was usually titular, as a non-governmental organization under the name of the Industrial Technology Research Institute (ITRI) [9]. Although it could participate in discussions at side events, it still hoped to obtain official participation status, thinking that already having joined international organizations such as the WTO and APEC would be a roundabout way to apply to participate. In terms of nominal participation, Taiwan has already considered applying for participation in the UNFCCC conference as an "emission entity." Since 2008, Taiwan also devised a way to join the World Health Assembly (WHA): via direct letter from the Executive Secretary of the Convention inviting Taiwan as an observer. However, the development of this issue is still awaiting political resolution by the international community.

Due to its ambiguous international status, Taiwan is in a unique position in the global climate regime. Taiwan, with regards to its grasp on international convention development and foreign consultations, suffers from a significant communications gap, thereby affecting the development of climate policy. Taiwan's climate

policy reflects its complex international status [9]. Facing post-Copenhagen climate negotiations, all countries ought to adopt new diplomatic thinking and policy. The most effective strategy would begin focusing, country-by-country, on advancing concrete mitigation actions that further broader, sustainable development objectives [35]. Taiwan ought to take advantage of this post-Kyoto period of consultations to rethink its own climate policy, to reduce interference of political factors, and to exert itself to integrate with international cooperative efforts.

5. Rethinking of Taiwan's climate policy

From the experience of Kyoto Protocol developments it can be understood that each country fights for its own rights and negotiating space. However, Taiwan, under its non-membership status in the United Nations, faces external problems far more difficult and complicated than other countries do while internally facing mixed issues of error perception and self-handicapping in its rights and obligations under international conventions. In such a difficult international environment, Taiwan must have a clear grasp of international negotiations, schedules, and priorities. In particular, IPCC has stressed that 2020 should be the year of peak of global GHG emissions, while the Copenhagen Accord views 2020 as a key year for the climate policy of all countries. In rethinking climate policy, Taiwan should consider 2020 as an important year in its own schedule. This study, with 2020 as a dividing line, reviews the setting of feasible reduction obligations and proposes short-term and long-term strategic thinking.

5.1. Reduction cost and obligation

Reduction cost can also be investigated to determine whether there is equity in reduction responsibility for each country [13,42]. Norway addressed their reduction cost as higher than Organization for Economic Cooperation and Development (OECD) countries [43]; similarly, U.S. or some developing countries frequently use high reduction cost as an excuse to refuse to accept responsibility of GHG reduction [44]. The marginal reduction cost (reduction by each country independently without emission trading) summarized from the study is shown in Table 5 [45–50]. It can be shown that the marginal reduction cost for each country mostly is below \$60/t-CO_2. However, if there is an emission trading scheme, the cost can be lowered to \$20 to 30/t-CO_2.

At this stage non-Annex I countries have no reduction obligation, so there is less research related to their reduction costs. In the absence of reduction targets, a top-down method to estimate overall marginal reduction costs cannot be used, so a project-based estimate of cumulative cost of reduction measures, a bottom-up approach to calculate marginal reduction costs must be used. The IPCC (2001) cited the Asian Least-cost Greenhouse Gas Abatement Strategy (ALGAS) that was conducted for 12 countries by United Nations Environment Programme (UNEP) and Asian Development Bank (ADB) from 1995 to 2000 [51]. The project results indicated that non-Annex I countries in 2020 would have marginal reduction cost less than \$25/t-CO_2. Compared to the country's baseline scenario for CO_2 emissions reduction, the majority were in the 10–25% reduction range, with Argentina at 11.5%, China 12.7%, and South Korea 5.7%. IPCC also cited other studies that showed marginal reduction costs in major developing countries in 2020 to be mostly around \$30/t-CO_2, with China at \$32/t-CO_2 in relation to baseline scenario cuts of 40%, India at \$28/t-CO_2 with 20% cuts, and Brazil at \$7/t-CO_2 with 80% cuts.

A past research proposed that Taiwan reducing CO_2 emissions by 10% below the BAU scenario by 2020 would have, in contrast, marginal reduction cost of about \$50/t-CO_2 [30]. In addition, past studies discussed the GHG emissions reduction obligations for rapidly industrializing countries, including Taiwan, and recommended that they should reduce their emissions in 2020 to 10% and 30% below baseline emissions respectively [52,53]. McKinsey & Company published GHG reduction cost curves to assess scenarios for global stabilization of GHG concentrations in the atmosphere at 450 ppm by 2030 and to explore the potential of various technology applications, basically setting marginal reduction costs at less than €40 per ton of CO_2e (about \$60/t-CO_2e) [54].

Based on the above cost analysis literature for Annex I and non-Annex I parties, each country between 2020 and 2030 has GHG marginal reduction cost around below \$60/t-CO_2, which can be used as reference to design the reduction objective for Taiwan. This suggested reduction cost is close to the upper limit of the marginal cost curve calculated by McKinsey & Company [54]. In addition, this research also suggests that setting the reduction target for CO_2 emissions 10% below BAU scenario in 2020. The difference among this suggested obligation and the results of other researches [52,53] were insignificant.

This proposal of reduction cost and obligation could resolve Taiwan's past problem of insufficient carbon price information and excessive burden in promoting GHG reduction.

5.2. Promoting a market mechanism

Based on the preliminary analysis of the carbon price and reduction responsibility described in the previous section, this study suggests that the reduction can be achieved through implementation of market mechanisms. The emissions trading scheme can provide clear carbon price information for all countries to comply with the Kyoto Protocol. In addition to encouraging private sector participation in investment and lowering the costs of GHG reduction, this could impel countries to prepare national climate change strategies [20,55]. Based on the preceding analysis, Taiwan should use market mechanisms to lower the cost of reductions; moreover, this would win international recognition of Taiwan's resolve to reduce GHG emissions and, domestically, allow gradual adaptation and establishment of industries related to basic information.

5.2.1. Establishment of a domestic carbon market: cost containment principles

Previous studies have pointed out that the establishment of carbon markets can introduces more energy-efficient technologies and increase the use of renewable energy [56,57]. For Taiwan, where climate policy equals energy policy, GHG emissions reduction could also improve energy efficiency and emphasize introduction of renewable energy technologies.

It would actually be impossible to cover all GHG emissions under the implementation of a carbon trading scheme. In the first phase of the EUETS, regulated industries included only the refining industry, energy industry, smelting, steel, and 11,500 energy-intensive cement, ceramics, glass, and paper manufacturers, accounting for 46% of European total CO_2 emissions [58]. Markussen and Svendsen analyzed some of the industries recognized in the negotiation process of the EUETS. For example, chemical industry products are too complex and difficult to monitor and control, so the trading system could not cover all sectors and industry types [59]. Chan et al. pointed out that in 2004 Taiwan's industrial sector accounted for 50.7% of total energy consumption, and the top 100 energy using manufacturers accounted for 50% of energy consumption of the industrial sector (with a very high CO_2 reduction potential) [60].

Based on theoretical and international experience, it is suggested that emissions trading rules and norms be targeted for larger emitters, mainly parts of the energy sector in Taiwan. As for residential and commercial, transport, agriculture, and other

Table 5
Comparison of the marginal reduction cost (excluded emissions trading) of major countries to achieve the targets of the Kyoto Protocol in 2010.

Country	Viguier et al. [45]				Criqui et al. [46]	Böhringer [47]	Ellerman et al. [48]	Zhang [49]	Tulpulé et al. [50]
	Model/methodology								
	EPPA	GTEM	POLES	PRIMES	POLES	Global CGE	EPPA	Econometric estimation	GTEM
	US\$95/t-CO_2e				US\$/t-CO_2	US\$/t-CO_2	US\$98/t-CO_2	US\$/t-CO_2	US\$92/t-CO_2
EEC[a]	43.4	42.3	51.3	36.8	45	19.02	74.5	2.5	194.7
USA	62.5	–	48.3	–	40.6	43.55	50.7	43.65	94.4
JPN	54.8	–	65	–	55.4	81.65	159.3	85.0	189
OOE[b]	–	–	–	–	33	20.41	63.5	9.1	–
CAN	–	–	–	–	47.5	62.65	–	–	227.7
GBR	24.8	30.8	36.3	33.5	–	–	–		–
DEU	32.5	48.3	29.2	24	–	–	–	–	–
FRA	37.1	–	60	39.3	–	–	–	–	–
ITA	40.1	–	96	47.2	–	–	–	–	–
ROE[c]	43.6	–	–	60.3	–	–	–	–	–
ESP	50.2	–	–	36.5	–	–	–	–	–
FIN	59.2	78.8	–	40.9	–	–	–	–	–
NLD	80.0	–	–	146.2	–	–	–	–	–
SWE	84.5	97.6	–	59.7	–	–	–	–	–
DNK	105	109.1	–	51.5	–	–	–	–	–
FSU[d]	–	–	–	–	0	0	0	0	0
Annex I average	–	–	–	–	–	–	–	–	87.8

[a] EEC indicates European Union.
[b] OOE indicates Other OECD Countries (Australia and New Zealand).
[c] ROE indicates the rest of Europe (France, Spain, Italy and the Netherlands).
[d] FSU indicates Former Soviet Union.
[e]US\$95/t-CO_2 indicates US dollar value in 1995, et cetera.

sectors, this study suggested they could be regulated by GHG emissions performance standards (EPS). EPS is similar to the energy efficiency standards now implemented in California [61]. Under a cap, the energy sector can be of technical and financial assistance to other sector reductions; an emissions reduction credit can be applied as the energy sector fulfills its reduction obligation, similar to the establishment of a domestic Clean Development Mechanism (CDM), as shown in Fig. 1, to promote energy conservation technologies.

To promote a carbon market is important. However, there needs to be a cost containment concept whereby compliance costs of the regulated entity during the period be limited in extent; namely, the regulated entity should not incur heavy losses, should maintain competitiveness, and under clearly defined costs be able to ensure efficiency and results [62]. In discussions of climate change issues, the concept of cost containment moved from discussion of emissions trading systems for traditional air pollutants then expanded to discussions of environmental management policy, such as cap and trade (price mechanism) programs and a carbon tax [63,64]. Imposition of a carbon tax in a clearly specified tax scenario could allow the regulated entity to receive correct price signals [65]. When the climate framework implements a cap and trade scheme, the major concern of regulated entities would be the high degree of cost uncertainty in implementing reduction [64]. In the U.S. a ceiling price was set for traditional air pollution emissions trading; if the market price exceeded the ceiling price, the

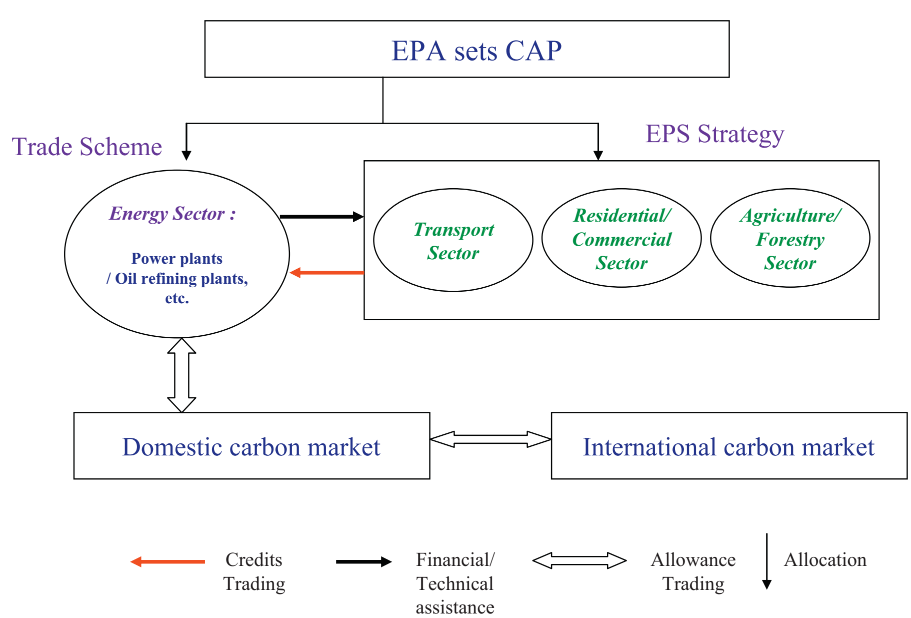


Fig. 1. Concept of combining energy efficiency standards (EPS) with emissions trading scheme.

U.S. Environmental Protection Agency would borrow against future emissions to auction emission rights, stabilize market prices, avoid excessive market volatility, as well as to let business understand that it could comply with the price cap. The U.S. Clean Air Act (CAA) set the price of NO_x and SO_2 at $4000/ton and the price of mercury at $35,000/lb. The 110th U.S. Congress also introduced climate related bills of similar design: borrowing 15% against future emissions (Lieberman–Warner, S.2191); carbon price not to exceed $12/t-$CO_2$ (Bingaman-Specter, S.1766); and borrowing 15% against future emissions (Lieberman–McCain, S.280) [64]. Moreover, as a suite, these provided that, should the price cap be exceeded, the U.S. government would introduce carbon reduction credits from cooperating foreign mechanisms into the domestic market to stabilize the carbon trading market. These cost containment practices comprise a "safety valve" concept.

Applied to developing countries, cost containment concepts should not be limited to design of trading systems but should be extended to overall design of climate policies so as to avoid unreasonable or unachievable reduction responsibilities. Clearly defined prices would encourage industrial sector confidence and government sector ability to integrate cost-effectiveness concepts into budget planning. Based on suggestion of Section 5.1, Taiwan could employ a carbon market price less than $60/t-$CO_2$ and under this regime actively examine other reduction strategies.

5.2.2. Linking international carbon markets

Sir Nicholas Stern, former World Bank chief economist, suggested that action be taken before 2020 to bring developing countries into the global carbon market, which would create a clear goal and a two-way market for emissions trading countries [16].

Tony Blair, former Prime Minister of the United Kingdom, recognized that a truly global carbon market could lower reduction cost 50% and, using the money market as an example, pointed out that 70 years ago the currency trading system was limited to trading between countries. With the transformation in capital management, inter-company and inter-personal currency trading grew rapidly, became a truly global market, substantially increased efficiency, and reduced state control of exchange rates and reserves. Because of globalization requirements on the international currency market, development of the private sector, the tripartite combination of national and international systems, and future carbon trading markets were all advanced [5].

If Taiwan can successfully construct the first phase of an operational carbon market, then, when independent regional carbon markets are integrated by global thinking, Taiwan will have the strength to negotiate with other countries and, by establishing domestic trading systems, seek opportunities for international integration. From the experience of operating a domestic carbon market, Taiwan could win recognition by the international community for actively promoting GHG reduction and dilute the interference of international political factors.

Of course, after 2020, when national reduction standards are highly uncertain, Taiwan will need to be careful and, with a level playing field as a starting point and not expecting things to happen overnight, step-by-step open a path toward international integration.

6. Disscusions and conclusions

For a long time, Taiwan's government departments and civil society, facing issues of GHG reduction, have focused only on setting reduction targets. It is well known that ever more countries and regions use setting GHG reduction targets as an artifice to make political declarations that are simply not implemented, a strategy criticized as "greenwashing." Of course, post-Kyoto negotiations draw out indecision and give politicians more room to maneuver. Looking ahead toward continued international climate framework discussions, the actions of all countries must be transparent, must be measurable, reportable, and verifiable (MRV) [30]. At the same time, governments must realize the necessity of "enhancing today's MRV framework to meet tomorrow's needs" [66].

In the past, Taiwan's response to the UNFCCC did have positive significance. Internationally, however, regarding non-Annex I countries not yet adhering to the Kyoto Protocol reduction mode, one can glimpse at the contents of the Copenhagen Accord (also stressed by the Kyoto Protocol) and see the intention of the principle of "common but differentiated responsibilities." If the future is a multi-track climate framework [15], no country will still adhere to Kyoto's reduction obligations and decision-making model. If the United States and China, two major GHG emitters do not seriously carry out the task of GHG emissions reduction, a few developing countries setting reduction targets for climate change mitigation does not in fact help much. The NAMAs proposed by the Copenhagen Accord for developing countries focus on actions; action is essential, not just the setting of targets.

This study proposes phased strategic thinking in developing GHG reduction strategies to conform to current international trends and strive towards international recognition. Furthermore, this study recognizes that cost containment in the price of carbon, with a suggested price below $60/t-$CO_2$, could create a clearly defined climate framework, could legalize and standardize GHG reduction, and substantially reduce the uncertainty of industry investment. Only genuine international cooperation, including Taiwan's, can substantially reduce GHG and mitigate climate change.

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